



Military Sealift Command's Oil Analysis Program



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INTRODUCTION TO MSC OIL ANALYSIS PROGRAM

The Military Sealift Command uses a number of different condition-based monitoring programs onboard its ships. Used oil analysis is the most widely accepted and implemented form of predictive maintenance technology. However, the success of this program requires an organized and sustained effort from shipboard and ashore personnel including testing laboratory.

FOUR KEYS TO SUCESSFUL OIL ANALYSIS PROGRAM

Clearly defined goals and program requirements ensure that the test performed fit the application and that the service is being fully utilized on an ongoing basis.

Representative samples ensure the true condition of the lubricant and component can be determined by reliable, accurate testing.

Proper communication promotes accurate interpretation and leads to increased confidence and interest in maintaining an active oil analysis program.

Complete and correct sample information speeds processing and increases the data analyst's ability to fully interpret the test results.

OUTLINE OF AN EFFECTIVE OIL ANALYSIS PROGRAM

1. Determine primary objectives.

Oil analysis can be applied to equipment utilization, maintenance and management.

Utilization

- Increase margins of operational safety
- Increase availability by decreasing downtime
- Increase overall component lifespan
- Control standby equipment and replacement part requirement
- Decrease fuel and oil consumption

Maintenance

- Identify and measure lube contamination and component wear
- Eliminate unnecessary overhauls or inspections
- Reduce in-service failures and field repairs

Establish proper lubricant service intervals

Management

Improve cost assessment and control for equipment, labor and materials

Improve equipment record-keeping procedures

Evaluate equipment designs/applications

Reveal faulty operational practices

The Shipboard Automated Maintenance Management (SAMM) system was developed by MSC to provide a standardized maintenance plan, which was needed to improve the operating efficiency and reduce the equipment failures that lead to unscheduled repairs and downtime. Oil analysis is part of the Condition Monitoring Program in SAMM developed and installed in support of predictive maintenance.

2. Select the proper tests for your application.

The application and goals of the oil analysis program help determine the number and type of tests that should be performed. Different combinations of physical and spectrochemical tests are used to measure the properties of the lubricant itself and determine the levels of contaminants and chemical elements suspended in the lubricant. The physical analysis concentrates on measuring certain physical characteristics of the lubricant. These tests also detect and measure contaminants and oil breakdown by-products. The elemental analysis identifies and measures selected metallic elements present in the lubricant as microscopic particles. The relative concentrations of these elements are used to monitor wear rates, detect contaminants and determine additive levels. MSC has clearly defined the proper oil test slate required for each equipment service or application.

3. Determine the proper sampling point and method.

Obtaining a representative sample is one of the most important parts of a scheduled oil analysis program. If the sample does not represent the true condition of the lubricant and component at the time of sampling, the reliability of both the test results and their interpretation is affected. Areas where lubricant is restricted or where contaminants and wear products tend to settle or collect should be avoided as sampling points. It is highly recommended to sample a component while it is running or within 30 minutes after shutdown. This ensures that wear products and

lubricant contaminants are thoroughly mixed with the lubricant and that the heavier wear particles have not settled out.

Once a proper sampling point and method has been chosen for a particular component, oil samples from that component should always be taken from the same point and the same method. MSC has begun implementation of an oil sampling standardization project that will help address the issue of sampling consistency throughout its fleet.

4. Determine the proper sampling interval.

When beginning a routine oil analysis program, the usual practice is to sample the entire group of units/components to establish initial baseline data and quickly spot any component with serious components. Once this process is complete, the customer and laboratory then agree on an initial routine sampling interval. The interval is based on results of the preliminary sampling, component manufacturer guidelines, OEM maintenance procedures and personnel scheduling with similar components and applications. Once fully established, the routine sampling interval may be adjusted. The SAMM system does this by establishing a schedule of required preventive maintenance actions for each piece of maintainable shipboard equipment and by documenting and tracking equipment maintenance history.

Once determined, routine sampling intervals should remain as constant as possible.

5. Establish consistent oil analysis baseline information.

If an oil analysis program is to furnish anything more than test data, the user must provide information on the equipment, component and lubricants in service.

Initial equipment registration can be easily accomplished by furnishing a consolidated equipment list. The following brief definitions are helpful:

UNIT ID NUMBER – A unique reference number for an entire functional unit. Examples include an engine serial number

COMPONENT – The overall type of oil-wetted system, such as engine, hydraulic or gearbox, from which the sample is taken.

OIL TYPE – The manufacturer, product name and SAE or ISO viscosity grade for the oil that was sampled.

A sample usually cannot be processed immediately if the customer name, unit and component ID and sample date are not provided. If you have sampled a particular machine before and do not ensure that the unit and component identifications

match what was originally provided, testing may be delayed and the results not filed correctly with other samples from that machine. Specific individuals should be assigned long-term responsibility for this portion of the program. Once this responsibility is established, a system of record keeping and correct sample identification should be initiated as soon as possible. SAMM maintains an equipment registration list for each ship and can be updated once alteration or deletion of equipment is completed.

6. Employ services of industry certified oil testing laboratory.

MSC has awarded its oil testing contract to PREDICT in September 2004. Founded in 1986, PREDICT's Used Oil Analysis, Wear Particle Analysis, and Vibration Analysis Service groups currently occupy a specially built 16,000 square-foot office, laboratory, and R&D facility in Cleveland, OH. PREDICT is a unique knowledge based company with an in-depth understanding of machinery, machinery problems and techniques for eliminating those problems.

7. Use data interpretation of test results properly.

The data interpretation separates the overall component and lubricant condition and the relative severity of contamination and wear into four main classifications:

NORMAL – Physical properties of the lubricant are within acceptable limits and no signs of excessive contamination or wear are present.

MONITOR – Specific test results are outside acceptable ranges, but are not yet serious enough to confirm abnormal conditions. Caution is advised. The initial stages of abnormality often show the same pattern of results as temporary conditions such as extended usage or over-loading.

ABNORMAL – Lubricant physical properties, contamination, and/or component wear is clearly unsatisfactory, but not critical. A confirming resample should be submitted. Additional diagnostic procedures may be needed to confirm each condition. Corrective actions are necessary to prevent reduction of service life or overall loss of performance.

CRITICAL – Lubricant physical properties, contamination, and/or component wear is clearly serious enough to require immediate diagnostic and corrective action to prevent major long-term loss of performance or component failure in service. Increases in operating hazard are likely. Short-term loss of performance may already be present. Large-scale repairs may be required. It may

be necessary to remove unit/component from service until a confirming resample is tested and diagnostics confirm that repairs are required.

These assessments are relative and are assigned using both *trend analysis* and OEM *threshold limits*. MSC uses both trend analysis and threshold limits.

Shipboard personnel are notified immediately on all samples where data interpretation detects critical condition. MSC will soon employ its oil analysis expert system to facilitate automation of data analysis requirements.

8. Provide proper feedback.

The interpretation guidelines accuracy is verified by comparing the lab test result-based predictions with actual conditions confirmed by inspection. In this way, the test interpretations are continually refined by practical experience. Feedback from customers include:

- Abnormal lubricant or component conditions that you suspect are present

- The findings of any inspection performed as a result of oil analysis program recommendations

- Abnormal lubricant or component conditions discovered that were not previously indicated by oil analysis

- Notification of servicing and maintenance performed

- Information concerning operating environment or equipment application changes

Shipboard and ashore engineers play an important role for the ongoing success of our oil analysis program. Vital machinery history information and feedback are reported and documented in SAMM. This information also provides our lifecycle engineers the necessary tools for scheduling corrective maintenance actions or repairs. Oil analysis data provide valuable information for improvement of system designs and application. TAGS-60 class TRANSALT request to install an oil purification system to the STERN THRUSTER GEAR lubrication system is one good example of system design improvements through oil analysis.

MSC OIL TEST SLATES

Test Slate 1	Viscosity, Water, TBN, Spectrochemical Analysis, Fuel Dilution, Oxidation by IR, Insolubles
Test Slate 2	Viscosity, Water, Spectrochemical Analysis, TAN, Particle Count
Test Slate 3	Viscosity, Water, Spectrochemical Analysis, TAN
Test Slate 4	Viscosity, Water, Spectrochemical Analysis, TAN, Direct Reading Ferrography
Test Slate 5	Viscosity, Water, TBN for diesel engine oils or TAN for non-diesel engine oils, Spectrochemical Analysis
Analytical Ferrography	

Test Slate 1 – Diesel Engines

Test Slate 2 – Vital Hydraulic Systems and Gas Turbine Engines

Test Slate 3 – Non-vital Hydraulic Systems, Circulating Oil Systems, Air Compressors, HVAC Compressors, Bearing systems

Test Slate 4 – Gear oil systems

Test Slate 5 – New oil testing

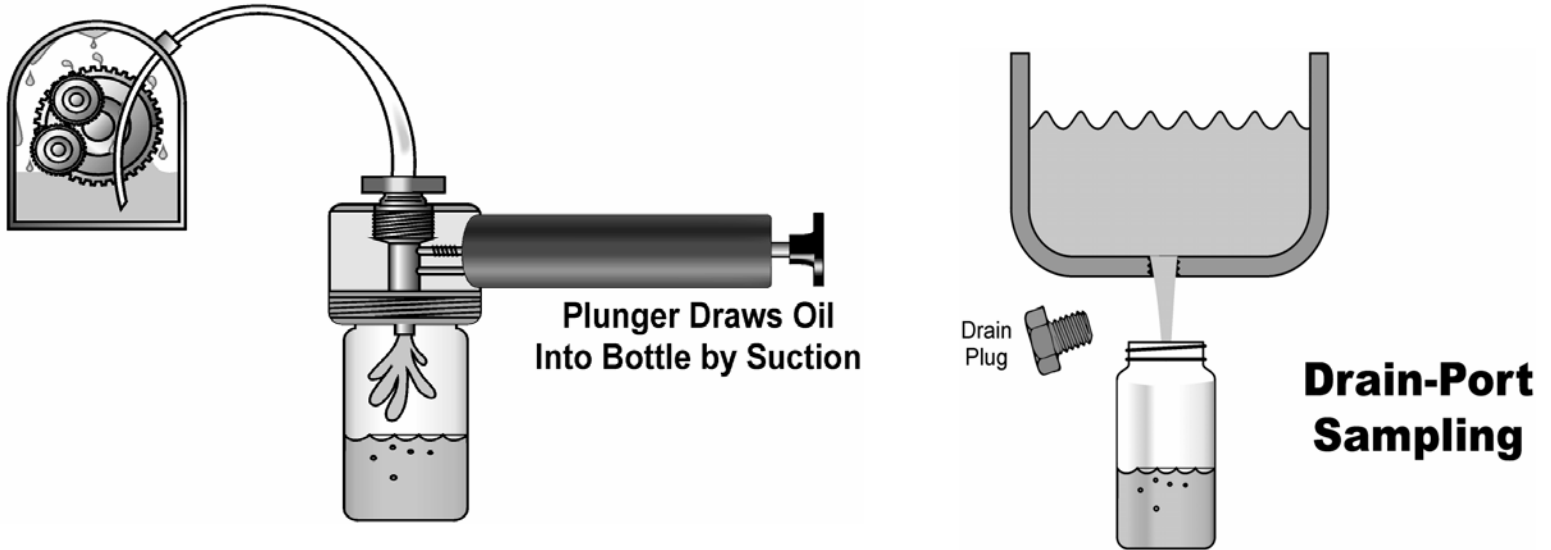
Proper Oil Sampling Points and Methods

Sampling to maximize benefits

- Samples contain wear metals and other debris that reveals information about the condition of the machinery.
- The sample must be representative of what is actually lubricating the moving parts.
- Sample from an “active zone” where oil is turbulent and any contaminants are suspended.
- Recommend sample a component while it is operational or within 30 minutes after shutdown.
- Recommend sample prior to a filtration or purification device.
- Avoid areas where lubricant flow is restricted or where contaminants and wear products tend to collect or settle if necessary.
- Recommend the following sample points:
 - A petcock or sampling valve installed PRIOR to the oil filter
 - An oil dipstick or other service opening using a vacuum pump
 - The sump or reservoir drain
- Once a proper sampling point and method is chosen for a particular component, oil samples from the component should always be taken from the same point with the same method.

Oil Sampling Points

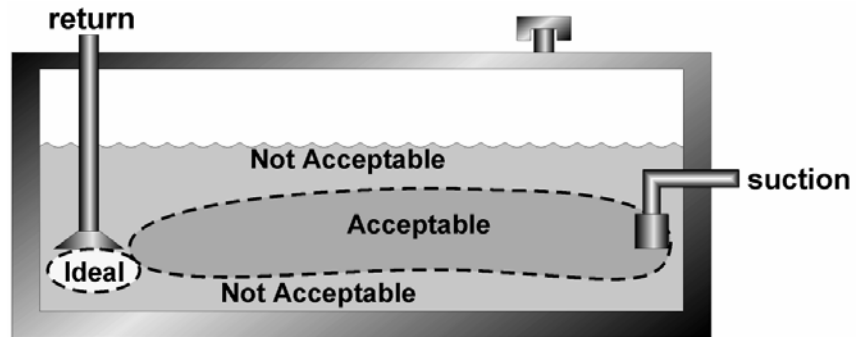
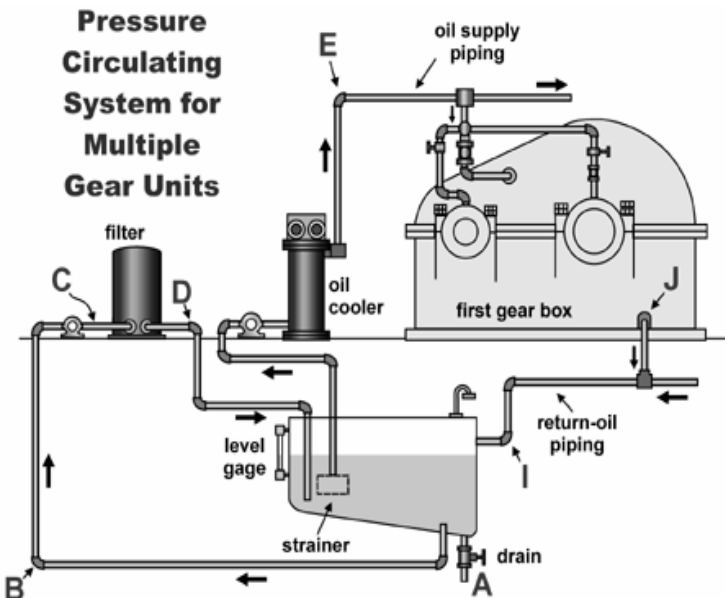
Splash Lubricated Gearboxes



- Desirable to sample the oil while the system is at normal operating conditions or 30 minutes after shutdown.
- These are the most common techniques.
- Drain port sampling is desirable to detect presence of contaminant.

Oil Sampling Points

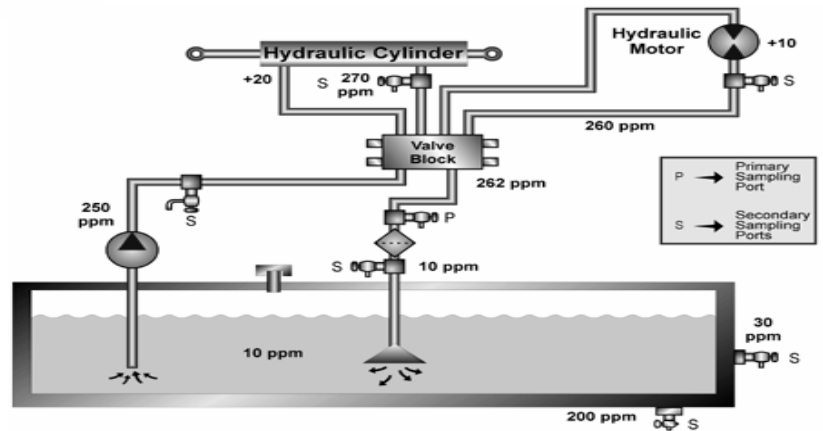
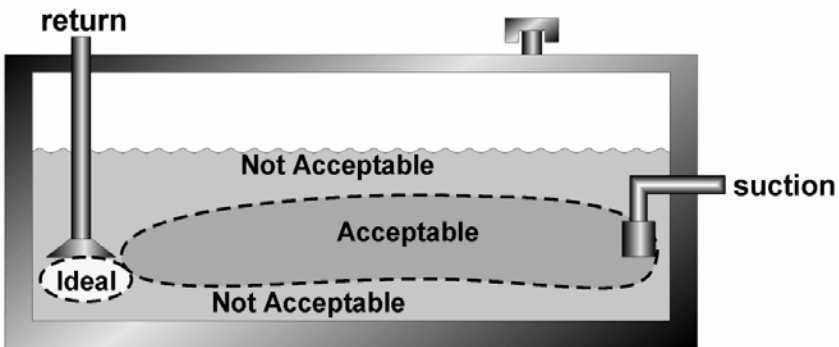
Turbines (Steam or Gas)



- Desirable to sample the oil while the system is at normal operating conditions.
- All points are valid for sampling, but point I is the best for a representative system sample.
- If the return line cannot be tapped, sample sump from as close to the return as possible.
- Secondary sampling points may be assigned to determine the source of highest wear concentration.

Oil Sampling Points

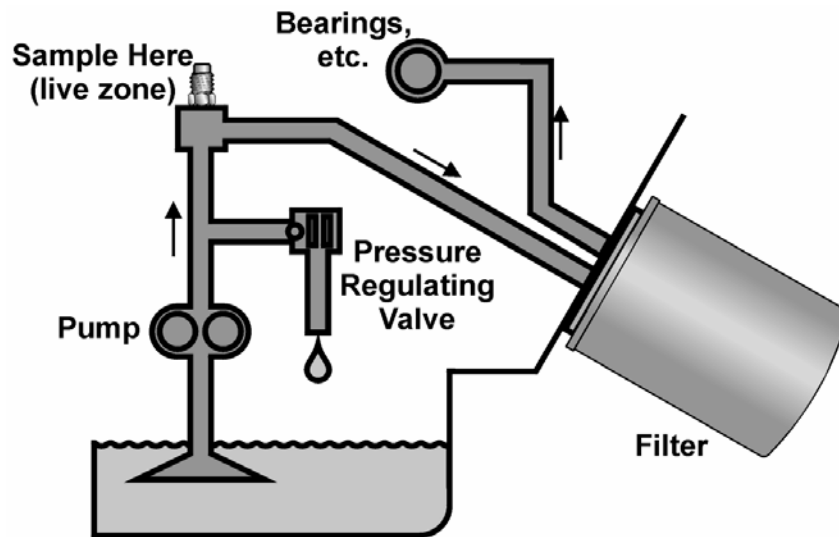
Hydraulic Systems



- Desirable to sample the oil while the system is at normal pressure and temperature.
- Desirable to draw sample from the system return before the sump and before any filters.
- If the return line cannot be tapped, sample sump from as close to the return as possible.
- Secondary sampling points may be assigned to determine the source of highest wear concentration.

Oil Sampling Points

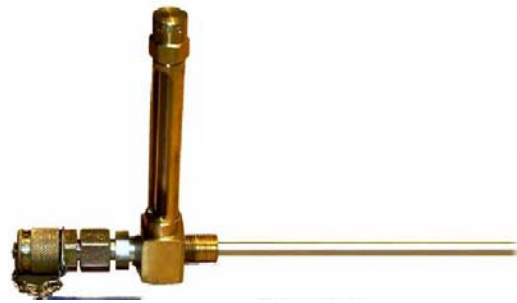
Engines



- Desirable to sample the oil while the engine is at normal operating load and temperature.
- Desirable to draw sample **BEFORE** the filter.
- Filtration wipes out information on component wear and can hide abnormal conditions.
- Sample from dipstick tube using a vacuum pump within 30 minutes after shutdown is an alternative method.

SAMPLING VALVE

Sample valves are designed to help user draw reflective oil samples from equipment. This is the simplest and most accurate method of sampling pressurized hydraulic, lubricating, and circulating systems, which also includes compressors and engines. The sampling section provides superior leak protection through a check valve and viton O-Ring sealed cap. The cap also protects the sampling section from contamination that can affect your oil samples. Used in conjunction with the proper accessories, sample valves are adaptable to pressure, static and vacuum locations. Using a gauge adapter, the sample port can be used to attach pressure gauges for troubleshooting purposes. Available in a variety of mating halves, they are easily adaptable to most applications. The sample ports and devices are now available in our Lube and Fuel Oil Handling Contract with Chase Supply.





SURVEY FORM GUIDE FOR SAMPLING STANDARDIZATION

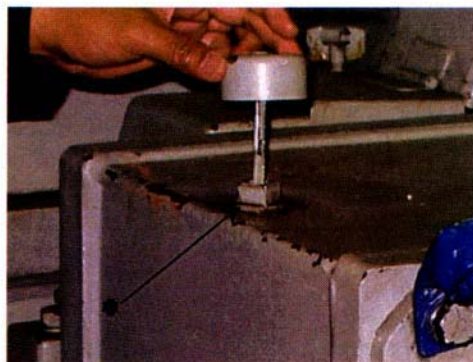
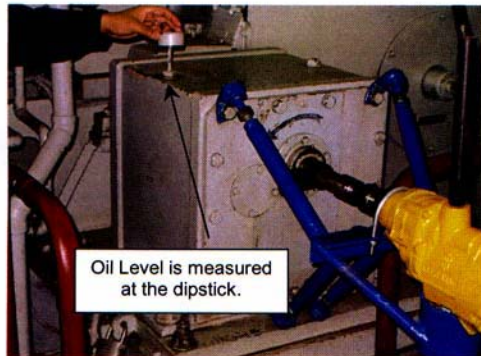
Sampling Method VP = Vacuum Pump, P = Sample Port, V = Valve or Plug

Ship Number
Ship Name
Equipment

T-AKR-303
USNS MENDONCA
Shaft Jacking Gear

PFA#	303030	Sample Point:	Reduction Gear Turning Gear
Like Equipment:	No.2 (303031)	Lubricant:	Mobilgear 630 ISO 220
Sampling Type:		Lubricant Symbol:	
		Sample Frequency:	M6

Lubricant Symbol, Color indicates



Sampling Procedures:

Sample this unit with a vacuum hose and tubing. Note: use new clean tubing and bottle for each sample. Check oil level after collection and add or inform appropriate personnel as required.

EQUIPMENT REGISTRATION IN SAMM

PFA Number	Equipment	Sample Point	Lubricant
5581001	MAIN ENGINE	MAIN ENGINE	MOBILGARD 300
5581002	NO.1 DIESEL FORKLIFT TRUCK	NO.1 DIESEL ENGINE FORKLIFT	MOBILGARD-1 SHC
5581003	NO.2 DIESEL FORKLIFT TRUCK	NO.2 DIESEL ENGINE FORKLIFT	MOBILGARD-1 SHC
5581006	NO.4 DIESEL FORKLIFT TRUCK	NO.4 DIESEL ENGINE FORKLIFT	MOBILGARD-1 SHC
5581010	STERN TUBE	STERN TUBE	MOBIL DTE OIL HEAVY MED
5581011	NO.1 MN PROP NO.1 LINESHAFT BEARING	NO.1 LINE SHAFT BEARING	MOBIL DTE OIL HEAVY MED
5581012	NO.1 MN PROP NO.2 LINESHAFT BEARING	NO.2 LINE SHAFT BEARING	MOBIL DTE OIL HEAVY MED
5581013	NO.1 MN PROP NO.3 LINESHAFT BEARING	NO.3 LINE SHAFT BEARING	MOBIL DTE OIL HEAVY MED
5581014	NO.1 MN PROP NO.4 LINESHAFT BEARING	NO.4 LINE SHAFT BEARING	MOBIL DTE OIL HEAVY MED
5581015	NO.1 MN PROP NO.5 LINESHAFT BEARING	NO.5 LINE SHAFT BEARING	MOBIL DTE OIL HEAVY MED
5581016	NO.1 MN PROP NO.6 LINESHAFT BEARING	NO.6 LINE SHAFT BEARING	MOBIL DTE OIL HEAVY MED
5581017	NO.1 MN PROP NO.7 LINESHAFT BEARING	NO.7 LINE SHAFT BEARING	MOBIL DTE OIL HEAVY MED
5581018	NO.1 MN PROP NO.8 LINESHAFT BEARING	NO.8 LINE SHAFT BEARING	MOBIL DTE OIL HEAVY MED
5581019	NO.3 DIESEL FORKLIFT TRUCK	NO.3 DIESEL ENGINE FORKLIFT	MOBILGARD-1 SHC
5581020	NO.10 RAS STA HIGHLINE WINCH	NO.10 HIGHLINE WINCH GEARBOX	MOBILGEAR 629
5581021	NO.1 FAS STA SPANWIRE WINCH	NO.1 SPANWIRE WINCH GEARBOX	MOBILGEAR 629
5581022	NO.2 RAS STA HIGHLINE WINCH	NO.2 HIGHLINE WINCH GEARBOX	MOBILGEAR 629
5581025	NO.5 RAS STA HIGHLINE WINCH	NO.5 HIGHLINE WINCH GEARBOX	MOBILGEAR 629
5581026	NO.6 RAS STA HIGHLINE WINCH	NO.6 HIGHLINE WINCH GEARBOX	MOBILGEAR 629
5581027	UTILITY BOAT	40 FT UTILITY BOAT ENGINE	MOBILGARD-1 SHC
5581029	NO.9 RAS STA HIGHLINE WINCH	NO.9 HIGHLINE WINCH GEARBOX	MOBILGEAR 629
5581031	NO.1 SSDG ENGINE	NO.1 SSDG ENGINE	MOBILGARD 412
5581032	NO.2 SSDG ENGINE	NO.2 SSDG ENGINE	MOBILGARD 412
5581033	NO.3 SSDG ENGINE	NO.3 SSDG ENGINE	MOBILGARD 412
5581034	NO.4 SSDG ENGINE	NO.4 SSDG ENGINE	MOBILGARD 412
5581035	NO.5 SSDG ENGINE	NO.5 SSDG ENGINE	MOBILGARD 412
5581036	NO.6 SSDG ENGINE	NO.6 SSDG ENGINE	MOBILGARD 412
5581037	NO.1 EMERG DIESEL GEN ENGINE	EMERGENCY DIESEL GENERATOR ENGINE	MOBILGARD 412
5581038	PORT RESCUE BOAT ENGINE	NO.1 RHIB BOAT DIESEL ENGINE	MOBILGARD 312
5581039	STBD RESCUE BOAT ENGINE	NO.2 RHIB BOAT DIESEL ENGINE	MOBILGARD 312
5581040	NO.1 EMERG DIESEL GEN ENGINE	DUMBWAITER MG SET PEDESTAL BEARING	MOBILGEAR 629
5581049	STORES LIFT REDUCTION GEARS	STORES ELEVATOR MG-SET BEARING	MOBILGEAR 629
5581050	NO.10 RAS STA HAULING WINCH	NO.10 HAULING WINCH GEARBOX	MOBILGEAR 629
5581051	NO.1 MAIN DSL ENG NO.1 TURBOCHARGER	MAIN ENGINE TURBO NO.1 FWD BRG	MOBIL RARUS SHC 1026
5581052	NO.2 RAS STA HAULING WINCH	NO.2 HAULING WINCH GEARBOX	MOBILGEAR 629
5581053	NO.1 MAIN DSL ENG NO.1 TURBOCHARGER	MAIN ENGINE TURBO NO.1 AFT BRG	MOBIL RARUS SHC 1026
5581054	NO.1 MAIN DSL ENG NO.2 TURBOCHARGER	MAIN ENGINE TURBO NO.2 FWD BRG	MOBIL RARUS SHC 1026
5581055	NO.5 RAS STA HAULING WINCH	NO.5 HAULING WINCH GEARBOX	MOBILGEAR 629
5581056	NO.6 RAS STA HAULING WINCH	NO.6 HAULING WINCH GEARBOX	MOBILGEAR 629
5581057	NO.1 MAIN DSL ENG NO.2 TURBOCHARGER	MAIN ENGINE TURBO NO.2 AFT BRG	MOBIL RARUS SHC 1026
5581059	NO.9 RAS STA HAULING WINCH	NO.9 HAULING WINCH GEARBOX	MOBILGEAR 629
5581061	ANCHOR WINDLASS	ANCHOR WINDLASS GEARBOX	MOBILGEAR 629
5581062	NO.2 AFT MOORING CAPSTAN	PORT MOORING CAPSTAN GEARBOX	MOBIL SHC 630
5581063	NO.1 AFT MOORING CAPSTAN	STBD MOORING CAPSTAN GEARBOX	MOBIL SHC 630

5581064	NO.1-3 CLEARWAY DOOR HYDRAULIC UNIT	1-3 CLEARWAY DOOR HPU	MOBIL DTE 16M
5581065	NO.2-4 CLEARWAY DOOR HYDRAULIC UNIT	2-4 CLEARWAY DOOR HPU	MOBIL DTE 16M
5581066	NO.5-7 CLEARWAY DOOR HYDRAULIC UNIT	5-7 CLEARWAY DOOR HPU	MOBIL DTE 16M
5581067	NO.6-8 CLEARWAY DOOR HYDRAULIC UNIT	6-8 CLEARWAY DOOR HPU	MOBIL DTE 16M
5581068	NO.9-11 CLEARWAY DOOR HYDRAULIC UNIT	9-11 CLEARWAY DOOR HPU	MOBIL DTE 16M
5581069	NO.10-12 CLEARWAY DOOR HYDRAULIC UNIT	10-12 CLEARWAY DOOR HPU	MOBIL DTE 16M
5581070	NO.1 STEERING GEAR UNIT	STEERING GEAR HYDRAULIC SYSTEM	MOBIL DTE 16M
5581071	NO.1 FAS STA NO.1 SADDLE WINCH	STATION NO.1 SADDLE WINCH NO.1	MOBILGEAR 629
5581072	NO.1 FAS STA NO.2 SADDLE WINCH	STATION NO.1 SADDLE WINCH NO.2	MOBILGEAR 629
5581073	NO.1 FAS STA NO.3 SADDLE WINCH	STATION NO.1 SADDLE WINCH NO.3	MOBILGEAR 629
5581074	NO.1 SS REFRIGERATION COMPRESSOR	NO.1 REEFER COMPRESSOR	MOBIL GARGOYLE ARC 300
5581075	NO.2 SS REFRIGERATION COMPRESSOR	NO.2 REEFER COMPRESSOR	MOBIL GARGOYLE ARC 300
5581076	NO.3 SS REFRIGERATION COMPRESSOR	NO.3 REEFER COMPRESSOR	MOBIL GARGOYLE ARC 300
5581077	NO.4 SS REFRIGERATION COMPRESSOR	NO.4 REEFER COMPRESSOR	MOBIL GARGOYLE ARC 300
5581078	NO.5 REFRIGERATION COMPRESSOR	NO.5 REEFER COMPRESSOR	MOBIL GARGOYLE ARC 300
5581079	NO.6 AIR CONDITIONING PLANT COMPRESSOR	NO.1 AC COMPRESSOR	MOBIL GARGOYLE ARC 300
5581080	NO.7 AIR CONDITIONING PLANT COMPRESSOR	NO.2 AC COMPRESSOR	MOBIL GARGOYLE ARC 300
5581081	NO.1 START AIR COMPRESSOR	NO.1 START AIR COMPRESSOR	MOBIL RARUS 827
5581082	NO.2 START AIR COMPRESSOR	NO.2 START AIR COMPRESSOR	MOBIL RARUS 827
5581083	NO.3 STARTING AIR COMPRESSOR	NO.3 START AIR COMPRESSOR	MOBIL RARUS 827
5581084	NO.1 CONTROL AIR COMPRESSOR	CONTROL AIR COMPRESSOR	MOBIL RARUS 827
5581086	NO.1 HP AIR COMPRESSOR	HP FORWARD AIR COMPRESSOR	MOBIL RARUS 827
5581087	NO.2 HP AIR COMPRESSOR	HP AFT AIR COMPRESSOR	MOBIL RARUS 827
5581089	HELO HANGAR LP AIR COMPRESSOR	NO.2 LP AIR COMPRESSOR (HELO DECK)	MOBIL RARUS SHC 1026
5581091	NO.1 FUEL OIL PURIFIER	NO.1 FUEL OIL PURIFIER	MOBIL SHC 630
5581092	FUEL AND LUBE OIL PURIFIER	NO.2 FUEL OIL / LUBE OIL PURIFIER	MOBIL SHC 630
5581093	LUBO PURIFIER	NO.3 LUBE OIL PURIFIER	MOBIL SHC 630
5581097	NO.1 FIRE PUMP DIESEL ENGINE	EMERGENCY FIRE PUMP TRANSMISSION	MOBILGARD 312
5581098	NO.1 FIRE PUMP DIESEL ENGINE	EMERGENCY FIRE PUMP ENGINE	MOBILGARD 312
5581100	NO.10 RAS STA HIGHLINE WINCH	NO.10 HIGHLINE WINCH NST	MOBIL DTE 16M
5581101	NO.1 FAS STA SPANWIRE WINCH	NO.1 SPANWIRE NST	MOBIL DTE 16M
5581102	NO.2 RAS STA HIGHLINE WINCH	NO.2 HIGHLINE WINCH NST	MOBIL DTE 16M
5581103	NO.1 MAIN DSL ENG NO.3 TURBOCHARGER	MAIN ENGINE TURBO NO.3 FWD BRG	MOBIL RARUS SHC 1026
5581104	NO.1 MAIN DSL ENG NO.3 TURBOCHARGER	MAIN ENGINE TURBO NO.3 AFT BRG	MOBIL RARUS SHC 1026
5581105	NO.5 RAS STA HIGHLINE WINCH	NO.5 HIGHLINE WINCH NST	MOBIL DTE 16M
5581106	NO.6 RAS STA HIGHLINE WINCH	NO.6 HIGHLINE WINCH NST	MOBIL DTE 16M
5581109	NO.9 RAS STA HIGHLINE WINCH	NO.9 HIGHLINE WINCH NST	MOBIL DTE 16M
5581110	NO.10 RAS STA HAULING WINCH	NO.10 HAULING WINCH NST	MOBIL DTE 16M
5581112	NO.2 RAS STA HAULING WINCH	NO.2 HAULING WINCH NST	MOBIL DTE 16M
5581115	NO.5 RAS STA HAULING WINCH	NO.5 HAULING WINCH NST	MOBIL DTE 16M
5581116	NO.6 RAS STA HAULING WINCH	NO.6 HAULING WINCH NST	MOBIL DTE 16M
5581119	NO.9 RAS STA HAULING WINCH	NO.9 HAULING WINCH NST	MOBIL DTE 16M
5581120	NO.10 RAS STA HIGHLINE WINCH ASD	NO.10 HIGHLINE WINCH ANTI-SLACK DEVICE	MOBIL SHC 634
5581122	NO.2 RAS STA HIGHLINE WINCH ASD	NO.2 HIGHLINE WINCH ANTI-SLACK DEVICE	MOBIL SHC 634
5581125	NO.5 RAS STA HIGHLINE WINCH ASD	NO.5 HIGHLINE WINCH ANTI-SLACK DEVICE	MOBIL SHC 634
5581126	NO.6 RAS STA HIGHLINE WINCH ASD	NO.6 HIGHLINE WINCH ANTI-SLACK DEVICE	MOBIL SHC 634

5581129	NO.9 RAS STA HIGHLINE WINCH ASD	NO.9 HIGHLINE WINCH ANTI-SLACK DEVICE	MOBIL SHC 634
5581130	NO.10 RAS STA HAULING WINCH ASD	NO.10 OUTHAUL WINCH ANTI-SLACK DEVICE	MOBIL SHC 634
5581132	NO.2 RAS STA HAULING WINCH ASD	NO.2 OUTHAUL WINCH ANTI-SLACK DEVICE	MOBIL SHC 634
5581135	NO.5 RAS STA HAULING WINCH ASD	NO.5 OUTHAUL WINCH ANTI-SLACK DEVICE	MOBIL SHC 634
5581136	NO.6 RAS STA HAULING WINCH ASD	NO.6 OUTHAUL WINCH ANTI-SLACK DEVICE	MOBIL SHC 634
5581139	NO.9 RAS STA HAULING WINCH ASD	NO.9 OUTHAUL WINCH ANTI-SLACK DEVICE	MOBIL SHC 634
5581140	NO.10 SLIDING BLOCK	NO.10 SLIDING BLOCK	MOBIL SHC 634
5581142	NO.2 SLIDING BLOCK	NO.2 SLIDING BLOCK	MOBIL SHC 634
5581145	NO.5 SLIDING BLOCK	NO.5 SLIDING BLOCK	MOBIL SHC 634
5581146	NO.6 SLIDING BLOCK	NO.6 SLIDING BLOCK	MOBIL SHC 634
5581149	NO.9 SLIDING BLOCK	NO.9 SLIDING BLOCK	MOBIL SHC 634
5581150	GALLEY DUMBWAITER	DUMBWAITER GEARBOX	MOBILGEAR 629
5581151	NO.1 CARGO/WEAPON ELEVATOR WINCH SPEED REDUCER	NO.1 CARGO ELEVATOR GEARBOX	MOBILGEAR 629
5581152	NO.2 CARGO/WEAPON ELEVATOR WINCH SPEED REDUCER	NO.2 CARGO ELEVATOR GEARBOX	MOBILGEAR 629
5581153	NO.3 CARGO/WEAPON ELEVATOR WINCH SPEED REDUCER	NO.3 CARGO ELEVATOR GEARBOX	MOBILGEAR 629
5581154	NO.4 CARGO/WEAPON ELEVATOR WINCH SPEED REDUCER	NO.4 CARGO ELEVATOR GEARBOX	MOBILGEAR 629
5581155	NO.5 CARGO/WEAPON ELEVATOR WINCH SPEED REDUCER	NO.5 CARGO ELEVATOR GEARBOX	MOBILGEAR 629
5581156	NO.6 CARGO/WEAPON ELEVATOR WINCH SPEED REDUCER	NO.6 CARGO ELEVATOR GEARBOX	MOBILGEAR 629
5581157	NO.7 CARGO/WEAPON ELEVATOR WINCH SPEED REDUCER	NO.7 CARGO ELEVATOR GEARBOX	MOBILGEAR 629
5581158	NO.8 CARGO/WEAPON ELEVATOR WINCH SPEED REDUCER	NO.8 CARGO ELEVATOR GEARBOX	MOBILGEAR 629
5581159	STORES LIFT REDUCTION GEARS	STORES ELEVATOR GEARBOX	MOBILGEAR 629
5581160	NO.1 ELECTRO HYDRAULIC CRANE	NO.1 CRANE HOIST GEARBOX	MOBILGEAR 629
5581161	NO.1 ELECTRO HYDRAULIC CRANE	NO.1 CRANE LUFF GEARBOX	MOBILGEAR 629
5581162	NO.1 ELECTRO HYDRAULIC CRANE	NO.1 CRANE SLEW GEARBOX	MOBILGEAR 629
5581163	NO.2 ELECTRO HYDRAULIC CRANE	NO.2 CRANE HOIST GEARBOX	MOBILGEAR 629
5581164	NO.2 ELECTRO HYDRAULIC CRANE	NO.2 CRANE LUFF GEARBOX	MOBILGEAR 629
5581165	NO.2 ELECTRO HYDRAULIC CRANE	NO.2 CRANE SLEW GEARBOX	MOBILGEAR 629
5581166	NO.3 ELECTRO HYDRAULIC CRANE	NO.3 CRANE HOIST GEARBOX	MOBILGEAR 629
5581167	NO.3 ELECTRO HYDRAULIC CRANE	NO.3 CRANE LUFF GEARBOX	MOBILGEAR 629
5581168	NO.3 ELECTRO HYDRAULIC CRANE	NO.3 CRANE SLEW GEARBOX	MOBILGEAR 629
5581169	NO.4 CRANE	NO.4 CRANE HOIST GEARBOX	MOBILGEAR 629
5581170	NO.4 CRANE	NO.4 CRANE LUFF GEARBOX	MOBILGEAR 629
5581171	NO.4 CRANE	NO.4 CRANE SLEW GEARBOX	MOBILGEAR 629
5581180	NO.2 FAS STA RAM TENSIONER	NO.2 FAS STA RAM TENSIONER	FYRQUEL 220 MLT
5581181	NO.5 FAS STA RAM TENSIONER	NO.5 FAS STA RAM TENSIONER	FYRQUEL 220 MLT
5581182	NO.6 FAS STA RAM TENSIONER	NO.6 FAS STA RAM TENSIONER	FYRQUEL 220 MLT
5581183	NO.9 FAS STA RAM TENSIONER	NO.9 FAS STA RAM TENSIONER	FYRQUEL 220 MLT
5581184	NO.10 FAS STA RAM TENSIONER	NO.10 FAS STA RAM TENSIONER	FYRQUEL 220 MLT
5581501	HULL STRUCTURE, GENERAL	ENGINE SLATE, SPARE 1	INFO NOT AVAILABLE
5581502	HULL STRUCTURE, GENERAL	ENGINE SLATE, SPARE 2	INFO NOT AVAILABLE
5581503	HULL STRUCTURE, GENERAL	ENGINE SLATE, SPARE 3	INFO NOT AVAILABLE
5581504	HULL STRUCTURE, GENERAL	ENGINE SLATE, SPARE 4	INFO NOT AVAILABLE
5581505	HULL STRUCTURE, GENERAL	ENGINE SLATE, SPARE 5	INFO NOT AVAILABLE

5581506	HULL STRUCTURE, GENERAL	ENGINE SLATE, SPARE 6	INFO NOT AVAILABLE
5581507	HULL STRUCTURE, GENERAL	ENGINE SLATE, SPARE 7	INFO NOT AVAILABLE
5581508	HULL STRUCTURE, GENERAL	ENGINE SLATE, SPARE 8	INFO NOT AVAILABLE
5581509	HULL STRUCTURE, GENERAL	ENGINE SLATE, SPARE 9	INFO NOT AVAILABLE
5581510	HULL STRUCTURE, GENERAL	ENGINE SLATE, SPARE 10	INFO NOT AVAILABLE
5581511	HULL STRUCTURE, GENERAL	HYDRAULIC SLATE, W/PC, SPARE 1	INFO NOT AVAILABLE
5581512	HULL STRUCTURE, GENERAL	HYDRAULIC SLATE, W/PC, SPARE 2	INFO NOT AVAILABLE
5581513	HULL STRUCTURE, GENERAL	HYDRAULIC SLATE, W/PC, SPARE 3	INFO NOT AVAILABLE
5581514	HULL STRUCTURE, GENERAL	HYDRAULIC SLATE, W/PC, SPARE 4	INFO NOT AVAILABLE
5581515	HULL STRUCTURE, GENERAL	HYDRAULIC SLATE, W/PC, SPARE 5	INFO NOT AVAILABLE
5581516	HULL STRUCTURE, GENERAL	HYDRAULIC SLATE, W/PC, SPARE 6	INFO NOT AVAILABLE
5581517	HULL STRUCTURE, GENERAL	HYDRAULIC SLATE, W/PC, SPARE 7	INFO NOT AVAILABLE
5581518	HULL STRUCTURE, GENERAL	HYDRAULIC SLATE, W/PC, SPARE 8	INFO NOT AVAILABLE
5581519	HULL STRUCTURE, GENERAL	HYDRAULIC SLATE, W/PC, SPARE 9	INFO NOT AVAILABLE
5581520	HULL STRUCTURE, GENERAL	HYDRAULIC SLATE, W/PC, SPARE 10	INFO NOT AVAILABLE
5581521	HULL STRUCTURE, GENERAL	HYDRAULIC SLATE, W/O PC, SPARE 1	INFO NOT AVAILABLE
5581522	HULL STRUCTURE, GENERAL	HYDRAULIC SLATE, W/O PC, SPARE 2	INFO NOT AVAILABLE
5581523	HULL STRUCTURE, GENERAL	HYDRAULIC SLATE, W/O PC, SPARE 3	INFO NOT AVAILABLE
5581524	HULL STRUCTURE, GENERAL	HYDRAULIC SLATE, W/O PC, SPARE 4	INFO NOT AVAILABLE
5581525	HULL STRUCTURE, GENERAL	HYDRAULIC SLATE, W/O PC, SPARE 5	INFO NOT AVAILABLE
5581526	HULL STRUCTURE, GENERAL	HYDRAULIC SLATE, W/O PC, SPARE 6	INFO NOT AVAILABLE
5581527	HULL STRUCTURE, GENERAL	HYDRAULIC SLATE, W/O PC, SPARE 7	INFO NOT AVAILABLE
5581528	HULL STRUCTURE, GENERAL	HYDRAULIC SLATE, W/O PC, SPARE 8	INFO NOT AVAILABLE
5581529	HULL STRUCTURE, GENERAL	HYDRAULIC SLATE, W/O PC, SPARE 9	INFO NOT AVAILABLE
5581530	HULL STRUCTURE, GENERAL	HYDRAULIC SLATE, W/O PC, SPARE 10	INFO NOT AVAILABLE
5581531	HULL STRUCTURE, GENERAL	GEAR SLATE, SPARE 1	INFO NOT AVAILABLE
5581532	HULL STRUCTURE, GENERAL	GEAR SLATE, SPARE 2	INFO NOT AVAILABLE
5581533	HULL STRUCTURE, GENERAL	GEAR SLATE, SPARE 3	INFO NOT AVAILABLE
5581534	HULL STRUCTURE, GENERAL	GEAR SLATE, SPARE 4	INFO NOT AVAILABLE
5581535	HULL STRUCTURE, GENERAL	GEAR SLATE, SPARE 5	INFO NOT AVAILABLE
5581536	HULL STRUCTURE, GENERAL	GEAR SLATE, SPARE 6	INFO NOT AVAILABLE
5581537	HULL STRUCTURE, GENERAL	GEAR SLATE, SPARE 7	INFO NOT AVAILABLE
5581538	HULL STRUCTURE, GENERAL	GEAR SLATE, SPARE 8	INFO NOT AVAILABLE
5581539	HULL STRUCTURE, GENERAL	GEAR SLATE, SPARE 9	INFO NOT AVAILABLE
5581540	HULL STRUCTURE, GENERAL	GEAR SLATE, SPARE 10	INFO NOT AVAILABLE
5581601	HULL STRUCTURE, GENERAL	TANK, STORAGE1	INFO NOT AVAILABLE
5581602	HULL STRUCTURE, GENERAL	TANK, STORAGE2	INFO NOT AVAILABLE
5581603	HULL STRUCTURE, GENERAL	TANK, STORAGE3	INFO NOT AVAILABLE
5581604	HULL STRUCTURE, GENERAL	TANK, STORAGE4	INFO NOT AVAILABLE
5581605	HULL STRUCTURE, GENERAL	TANK, STORAGE5	INFO NOT AVAILABLE
5581606	HULL STRUCTURE, GENERAL	TANK, STORAGE6	INFO NOT AVAILABLE
5581607	HULL STRUCTURE, GENERAL	TANK, STORAGE7	INFO NOT AVAILABLE
5581608	HULL STRUCTURE, GENERAL	TANK, STORAGE8	INFO NOT AVAILABLE
5581609	HULL STRUCTURE, GENERAL	TANK, STORAGE9	INFO NOT AVAILABLE
5581610	HULL STRUCTURE, GENERAL	TANK, STORAGE10	INFO NOT AVAILABLE
5581611	HULL STRUCTURE, GENERAL	TANK, STORAGE11	INFO NOT AVAILABLE
5581612	HULL STRUCTURE, GENERAL	TANK, STORAGE12	INFO NOT AVAILABLE
5581613	HULL STRUCTURE, GENERAL	TANK, STORAGE13	INFO NOT AVAILABLE
5581614	HULL STRUCTURE, GENERAL	TANK, STORAGE14	INFO NOT AVAILABLE

5581615	HULL STRUCTURE, GENERAL	TANK, STORAGE15	INFO NOT AVAILABLE
5581641	HULL STRUCTURE, GENERAL	BUNKER/BARREL/DRUM ENGINE OIL SLATE, SPARE 1	INFO NOT AVAILABLE
5581642	HULL STRUCTURE, GENERAL	BUNKER/BARREL/DRUM HYDRAULIC W/PC OIL SLATE, SPARE	INFO NOT AVAILABLE
5581643	HULL STRUCTURE, GENERAL	BUNKER/BARREL/DRUM HYDRAULIC W/O PC OIL SLATE, SPA	INFO NOT AVAILABLE
5581644	HULL STRUCTURE, GENERAL	BUNKER/BARREL/DRUM GEAR OIL SLATE, SPARE 4	INFO NOT AVAILABLE

HOW TO PRINT LUBE OIL LABELS IN SAMM

Lube oil labels can be printed from three different modules, Tools, Workbook and Planned Maintenance.

Tools Module

- 1) Open the “Tools” module by a single left click on the SAMM Toolbar.
- 2) Open the “Scheduler” by a single left click on the “Scheduler” icon (the Scheduler icon will only activate when you see the icon change appearance when moving the mouse pointer over the icon. The Scheduler might take a couple of minutes before opening – be patient).
- 3) At the bottom of the Scheduler window you will see a section titled “Print Reports”. Check the box to the left of the “Lube Oil Labels” by left clicking in the box.
- 4) Click the “Print” button at the bottom right of the Scheduler window.
- 5) A window will appear titled “Align and Print Labels”. This window contains a listing of all lube oil sampling required on the current schedule. If you require to print all of these labels you can select all either by left clicking on the red check at the top of the window or by selecting “Action” from the menu and then clicking “Check All Labels”. Either of these actions will place a check in all of the boxes to the left of the window. If all that is required is to select a few of these labels, left click in the box on the left of the window so that a check appears in the box and continue this until you have selected all the labels you require.
- 6) To check that you have selected the correct items click the “Print Preview” button at the top of the window which looks like a piece of paper with a magnifying glass on it. This will print to your screen a view of the labels.
- 7) **BEFORE PROCEEDING TO PRINT THE LABELS LOAD THE LUBE OIL LABEL SHEETS INTO THE PAPER TRAY OF THE PRINTER.**
- 8) Having loaded the correct paper, click on the print icon, which looks like a printer.
- 9) The labels should print correctly as is but should there be some misalignment, going back to the “ALIGN AND PRINT LABELS” window can make adjustments. At the top of this window is an icon, which looks like a printer with a spanner across the top of it. Click on this icon and adjustments can be made to the spacing of labels and the number of

columns of labels that will be printed on a sheet. **HINT:** Some users want to print two labels for each sample, one for the bottle and one for their records – select Two Columns if you require duplicate labels.

10) After the print button has been selected the user is asked “Did Labels Print Satisfactorily”. If the user selects YES, the labels will be printed and the planned maintenance action will be completed and reprints of labels will not be allowed using this procedure. If the user selects No then labels can be reprinted and the planned maintenance actions will not have been completed.

Workbook Module

- 1) Open the “Workbook” by a single left click on the SAMM toolbar.
- 2) Find a Sample Lube Oil action indicated by an icon with an “L” in it, in the left hand column of the details window.
- 3) Single left click on the “L” icon which will open the window “Align and Print Labels” and proceed as in item 5) above.

Planned Maintenance and Workbook Print Selections

- 1) In either the Planned Maintenance or Workbook modules, just to the right of the PRINT button at the top of the window, is a small arrow, click this arrow.
- 2) At the bottom of the menu that appears is a selection for Lube Oil Label printing, click this selection.
- 3) The window that opens will be titled “Align and Print Labels” then proceed as in item 5) above.

Troubleshooting Lube Oil Label Printing

How Do I Reprint a Label After PM Completion?

If you return to the “Align and Print Labels” window using any of the methods described above, you will see a menu item on the top of the window named Configure. Click on Configure and at the bottom of the menu that shows is an item Reprint that you should click on. This will return you to all lube oil labels for printing prior to completion in that schedule.

How Do I Print a Lube Oil Label Not On the Schedule?

In the Planned Maintenance module select the equipment you require to print a lube oil label for. Then select the maintenance action for sampling lube oil. If you then open the details window, and select the left hand tab named Schedule, you will see a button titled Put on Schedule, which should be clicked. If you then go to print lube oil labels using any of the methods above you will see the item selected on the list.

SAMPLE LABEL INFORMATION

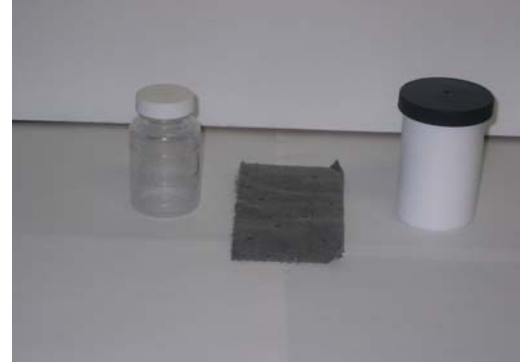
Provide the following information in the blank sample label if SAMM-generated labels are not available:

1. PFA Number – this consist of the Vessel Number and 3-digit equipment number as provided in the Equipment Registration List - 5581001
2. Ship's Name – USNS SATURN
3. Equipment Description – MAIN ENGINE
4. Lubricant in service – MOBILGARD 300
5. Date of sample taken – AUG 31, 2004

SAMPLING KIT

■ INVENTORY

- ◆ 20 CLEAR BOTTLES
- ◆ 20 BLACK JARS
- ◆ Prepaid express mailing labels
- ◆ Blank label paper
- ◆ Pre printed labels



■ Put full sample bottle in plastic bag, then into white cylinder

- ◆ Label goes on sample bottle
NOT white cylinder!



SAMPLE PUMP KIT

- Sample Pump
- Purge Bottle
- Tubing
- Instructions

**Note: use
separate tubing
for each sample
point**



Sending Sample Bottles

- **Put white cylinders back in box**
- **Ship to lab using preaddressed DHL or USPS mailers**
- **MSC Contracted Laboratory address**
 - **PREDICT**
 - **9555 Rockside Road, #350**
 - **Cleveland, OH 44125**
 - **1-800-543-8786**
 - **Attn: Mr. Pat Kilbane**
- **See mailing instructions inside sample bottle kits**

DHL and USPS mailers are only to be used for sending used oil samples to the oil lab

Note 1: When in CONUS, use the DHL Domestic air waybill mailers only. When OVERSEAS, use the DHL International air waybill mailers only. When in Diego Garcia, use the USPS priority mailers only.

Note 2: Place \$0.00 on Customs Value.

GENERAL GUIDANCE FOR SHIPBOARD TESTING

Go/No Go Criteria:

"Clear" means there is no visible presence of sediment or dirt.

"Bright" means the sample is not cloudy or hazy and has no visible free water.

ENGINE OIL STORAGE TANKS

Take an oil sample from each storage tank after filling the tank with new oil.

Perform a visual inspection of the sample for clear and bright criteria.

Test for viscosity using the onboard viscometer and record the reference viscosity reading. Viscosity should be within the SAE grade for the oil as provided in Table 1. Repeat test procedures for consistency and repeatability as required.

If a sample fails either test, submit oil sample for complete laboratory analysis.

Perform TBN test and record new TBN reference value.

NON-ENGINE OIL STORAGE TANKS

Take an oil sample from each storage tank after filling the tank with new oil.

Perform a visual inspection of the sample for clear and bright criteria.

Test for viscosity using the onboard viscometer and record the reference viscosity reading. Viscosity should be within the ISO viscosity grade for the oil as provided in Table 1. Repeat test procedures for consistency and repeatability as required.

If a sample fails either test, submit oil sample for complete laboratory analysis.

MAIN, AUXILIARY AND EMERGENCY DIESEL ENGINES

Engine Type/Status Testing Frequency

Operating Main and Auxiliary Engines Test viscosity daily using onboard viscometer

Standby or Secured Main and Auxiliary Engines Test viscosity weekly and prior to start-up using onboard viscometer

Emergency Diesel Engines Test viscosity weekly and prior to start-up using onboard viscometer

If the viscosity test is satisfactory, there are no other shipboard tests required for used engine oil. If the engine oil fails the viscosity test, then additional tests shall performed as outlined below to determine other physical properties of the oil. For single grade or multi-grade oils, the viscosity readings should be within the SAE grade of the oil as provided in Table 1. Use viscosity @ 100°C readings from the onboard viscometer. Repeat viscosity test for consistency and repeatability as required. If the viscosity is not within the SAE grade range, submit an oil sample for complete laboratory analysis and perform the following additional shipboard testing:

If the viscosity reading @ 100°C is below the minimum range for the SAE grade or W grade, perform TBN test using onboard TBN tester. TBN depletion should not exceed 50% of the new oil reference TBN. Perform oil and filter change if viscosity and TBN results are low.

If the viscosity reading @ 100°C is above the maximum range for the SAE grade, perform water and insoluble tests using onboard water-in-oil and insoluble testers. Water should not exceed 0.2% and insoluble should not exceed 2.0%. Perform purification of oil if water and insoluble results exceed these limits.

OPERATING MAIN GAS TURBINES AND REDUCTION GEARS

Take oil sample from operating gas turbines and its reduction gears weekly and perform visual inspection for presence of water and visible

particles. If the sample passes the visual inspection, no further shipboard testing is required. If sample fails visual inspection, submit sample for complete laboratory analysis. Perform water test using onboard water-in-oil tester if water is suspected. Water should not exceed 0.1%. Perform oil purification and check source of water contamination if water content exceeds this limit.

OPERATING MAIN AND SHIP'S SERVICE STEAM TURBINES AND REDUCTION GEARS

Take an oil sample from operating steam turbines and reduction gears daily. Perform visual inspection for presence of water and visible particles. If the sample passes the visual inspection, no further shipboard testing is required. If sample fails visual inspection, submit sample for complete laboratory analysis. Perform water test using onboard water-in-oil tester if sample is cloudy/hazy. Water should not exceed 0.2%. Perform oil purification and locate and repair source of water contamination if water content exceeds this limit.

Note: Main Steam Turbine and Reduction Gear oil shall be purified sump to sump for a minimum of 12 hours per day when in operation.

OPERATING CONTROL AIR COMPRESSORS

Take oil sample from operating air compressors daily. Perform visual inspection for presence of water and visible particles. If the sample passes the visual inspection, no further shipboard testing is required. If sample fails visual inspection, submit sample for complete laboratory analysis. Perform water test using onboard water-in-oil tester if sample is cloudy/hazy. Water should not exceed 0.2%. Perform oil change and locate and repair source of water contamination if water content exceeds this limit.

OTHER OPERATING, SECURED OR STANDBY EQUIPMENT

Perform onboard oil analysis only as deemed necessary by the Chief Engineer taking into consideration prevailing shipboard equipment operating conditions and/or suspected problems.

DOCUMENTATION AND REPORTING

Document test results and actions taken, if any, in electronic lube oil test log and submit via email to edgardo.guevara@navy.mil or LOHE@chasesupply.biz. For a copy of the electronic log, please submit your request to MSCHQ-N7_Orders.fct@navy.mil.

SAE VISCOSITY GRADES FOR ENGINE OILS

The viscosity classification system used for engine oils is outlined in Table 1. The Society of Automotive Engineer (SAE) developed this system. This system specifies ranges of viscosity at both low temperatures and high temperatures. The numbers followed by the letter W (e.g., 5W, 10W, 15W, and 20W) identify oils suitable for winter service. The numbers without the W (e.g., 20, 30, 40 and 50) identify oils suitable for higher temperature service. Viscosity ranges for these oils are specified at 100°C. If oil meets one of the W grade specifications and also meets the viscosity specifications at 100°C, that oil is then called a multi-grade oil (multi-viscosity or cross-grade).

TABLE 1. VISCOSITY CLASSIFICATION

SAE VISCOSITY NUMBER CRANKCASE OILS

SAE GRADE	RANGE (cST) @ V100deg C
0W	3.80- *
5W	3.80-*
10W	4.10-*
15W	5.60- *
20W	5.60-*
25W	9.30-*
20	5.60-9.29
30	9.30-12.49
40	12.50-16.29
50	16.30-21.89
60	21.90-26.09

SAE VISCOSITY NUMBER GEAR LUBRICANTS

SAE GRADE	RANGE (cST) @V100 deg C
75W	4.10-*
80W	7.0)-*
85W	11.0-*
90	13.50-23.99
140	24.00-40.99
250	41.00-UP

ISO VISCOSITY GRADE

ISO GRADE	RANGE (cST) @ V40deg C
22	19.8-24.2
32	28.8-35.2
46	41.4-50.6
68	61.2-74.8
100	90.0-110
150	135-165
220	198-242
320	288-352
460	414-506
680	612-748
1000	900-1100
1500	1350-1650

* - No requirement

USED OIL TESTING AND ANALYSIS



Viscosity

Viscosity is defined as a fluid's resistance to flow.

It is considered the most important property of lubricating oil, and a key indicator of oils' serviceability.

Engine oils are assigned an SAE grade based on their viscosity at 100° C - "The oils' weight"

Industrial oils are rated by an ISO grade (viscosity at 40° C)

Description: Capillary flow test

Results are reported in centistokes (cSt) @ 40° C or 100° C

Causes for change:

High Viscosity: Oil thickening. Caused by:

- Oxidation
- Soot or excessive dirt (insolubles)
- Addition of Incorrect lubricant

Low Viscosity: Oil thinning. Caused by:

- Contamination with fuel
- Addition of Incorrect lubricant



Water Dilution

Description: Two step process:

Screen with water test by hot plate.

If water is detected, water test by Karl Fischer is performed to measure in PPM:

Titration with chemical reagent

Very accurate

Causes for change:

- Leaky water system (liners, o-rings, telescoping pipes)
- Sodium, boron and silicon levels indicate coolant additives
- Leaky steam system (heating coils)
- Condensation (idle equipment)

Significance:

Increases the oxidation rate of the oil:

Acts as a catalyst to break chemical bonds

Corrosion to parts:

Steel parts rust

Reduce load-handling ability of oil:

Lower viscosity



Cavitation (erosion)
Increases sludge, lacquer, and deposits
Additive reaction
Additive depletion

Total Acid Number (TAN)

Description: Titration where amount of base Potassium Hydroxide (KOH) is added to the sample. Measured and reported in mgKOH/g of sample.

Causes for change:

Natural reaction of oil with heat, oxygen and water
Forms organic acids.

Corrosive to component parts
Causes sludge, lacquer and deposit formation



Total Base Number (TBN)

Description: Titration where amount of hydrochloric acid (HCL) is added to the sample. Measured and reported in mgKOH/g of sample.

Measurement of the amount of detergents /dispersants in diesel engine oil

Causes for change:

Neutralize inorganic acids formed during combustion
Sulfuric (H_2SO_4)
Nitric (H_2NO_3)

Neutralize organic acids formed from oil oxidation

A TBN drop of 40-50% off the new diesel engine oil TBN indicates oil is at the end of useful life.

Fuel Dilution

Description: Fuel Dilution is typically the result of partially combusted diesel fuel blow-by into the diesel engine lubricant. The primary test for determining the amount of fuel present in the oil is the Gas Chromatography test. As the temperature increases to the evaporation point of a molecule, it evaporates, is carried into the detector by an inert gas, and quantified by percentage.

Causes for change:

- Leaking or faulty injectors, leaking fuel lines
- Incorrect injector settings
- Operation at reduced load (<40%) & prolonged engine idling
- Short operating times when engine does not get to normal operating temperature

Significance:

- Reduced viscosity:
 - Increased component wear
- Reduced flash point:
 - Crankcase explosions
- Additive drop-out:
 - Low TBN.
 - Increased sludge, lacquer, and deposits

Oxidation Test (for Diesel Engines only)

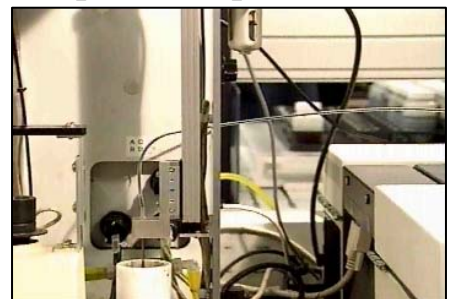
Description: Infrared light is passed through a cell containing the sample.

Amount of light absorbed is proportional to the amount of oxidation.

Results are Measured in A/cm at a given wavelength and reported in percent.

Causes for change:

- Natural reaction of oil with heat and oxygen
- Forms organic acids.
 - Corrosive to engine parts
 - Causes sludge, lacquer and deposit formation



Soot Index Test (for Diesel Engines Only)

Description: Infrared light is passed through a cell containing the sample. The amount of light absorbed is measured. Reported in percent. Amount of light absorbed is proportional to the amount of Soot.

Causes of change: Soot can be generated at an accelerated rate due to:

- Improper air/fuel mixture resulting from over-fueling or restricted flow

through the air intake

Incomplete combustion and/or low compression

Worn rings (blow-by)

Oil breakdown (coking) from excessive operating temperatures or local hot spots

Significance: If soot reaches a significant level, it can cause the oil to thicken and sludge deposits can form. If sludge is heated, it becomes hard carbon.

Elemental Analysis

Description: Rotary Disk Electrode Spectroscopy

A used oil sample is placed into a sample holder. Then a spinning carbon disk is partially immersed in the oil. A specific high voltage is placed across a carbon rod (above the carbon disc) and the carbon disc. The oil is carried into the voltage as the disc spins during the test cycle. The instrument calculates the quantity (in PPM) and type of elements found in the oil sample.

Causes for change:

Corrosion, “normal” wear, large chunks getting crushed between components.

Significance: Specific component wear can be traced through these results.

The results can be a precursor to potential failure.

Rate of wear (PPM/oil operating hour) indicates severity of condition.

Increasing concentrations of particles may be removed through filtration

Wear Metals Sources:

Iron (Fe)	Cylinders, Gears, Crankshafts, Liners, Housings, Rust
Chromium (Cr)	Rings, Rods, Plating, Roller/Taper Bearings
Lead (Pb)	Bearing Overlays, Additive in some gear lubes & gasoline
Copper (Cu)	Bearings, Bushings, Thrust-Washers, Friction Plates clutches, Oil Cooler tubing, Oil Additive
Tin (Sn)	Bearings, Bushings, Pistons, Plating
Aluminum (Al)	Pistons, Bearings, Pumps, Blowers, Rotors, Thrust-Washers
Nickel (Ni)	Valves or anti-friction bearing races
Silicon (Si)	Seals, gaskets, ingested dirt, coolant additive, anti-foaming additive
Titanium (Ti)	Gas turbine components
Vanadium (V)	Trace element associated with residual fuel



Particle Counting

Description: Automated Particle Counter

Method used to determine the number and size of solid particles in a milliliter of fluid. Computer reads and classifies the particles by the changes in light received by the photo-detector as the fluid passes through the particle counter. Three-size range; 4 micron, 6 micron and 14 micron represent the ISO 4406 standard.

Causes for change:

Abnormal particle levels are associated with increased wear, operational problems with close tolerance components, fluid contamination or degradation or loss of filter efficiency.

Significance: Provides trend that can indicate increases in abnormal wear.

- Quantitative results

- Sensitive to water and contaminants

- Only useful for clean running systems such as hydraulics and turbines and where contaminant debris is not generally expected.



WEAR PARTICLE ANALYSIS

DIRECT READING FERROGRAPHY

Description:

Method measures the amount of ferrous debris present in the sample at two points. This quantifies the amount of wear debris over 5 microns in size (DL) against the amount of wear debris under the 5-micron size (DS). The magnetic debris “precipitates” out over two small windows near the entry end and the amount of light blockage is measured.

Significance: A trending device used to reduce the frequency of analytical ferrography. Quantitative analysis

Advantages

Insensitive to air, water or any other fluid contaminant in the lubricant being tested

Simple and inexpensive test to monitor ferrous wear generated during normal conditions to determine the onset of abnormal wear.

Generally, fast test taking about four to six minutes to complete.

Applicable to opaque fluids as well as heavily contaminated fluids

Limitations

Insensitive to non-ferrous, non-magnetic particles

ANALYTICAL FERROGRAPHY

Description: High power microscope used to determine shape, composition and color of wear particles. Manual analysis triggered by Direct Reading Ferrography or as requested by data analyst.

Significance: Exact mechanism of machine wear can be identified along with relative proportion of different types of particles.

Particle Identification

Particle Classifications

Particle Types (Wear Mechanisms)

Particle Sources

Severity of Wear

Particle Classifications

Ferrous - Magnetic, Paramagnetic; Fe, Fe₂O₃, Fe₃O₄; Stainless Steel

Non-Ferrous - Copper Alloys, Aluminum, Babbitt Metals, Zinc, Chrome, etc

Contaminant- Fluids, Dust, Dirt, External Process, Manufacturing Debris,
Filter Material, Friction Polymers, Organic Matter

Particle Types and Sources

Normal Rubbing Wear - normal machine wear

Cutting Wear - misalignment or abrasive contamination in lubricant

Severe Sliding Wear - excessive load/speed on sliding surface

Gear Wear - fatigue, scuffing or scoring of gear teeth

Bearing Wear - rolling contact failure

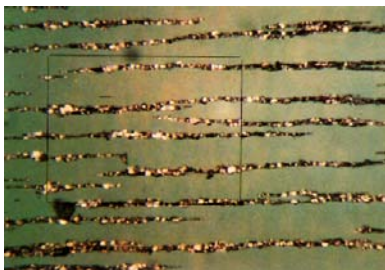
Corrosive Wear - oil additive depletion

Spheres - early warning of rolling element bearing failure

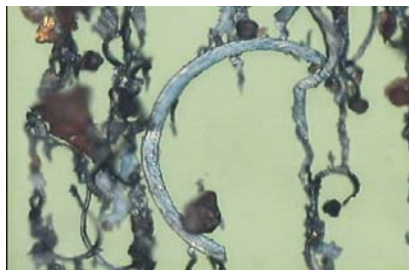
Black and Red Oxides - insufficient lubrication or water in oil condition

Contaminants such Sand/Dirt, Friction Polymers, Fibers

NORMAL RUBBING WEAR



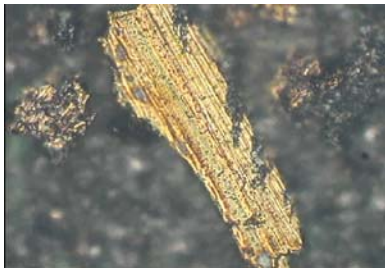
CUTTING WEAR



COPPER ALLOY BEARING WEAR



SLIDING WEAR



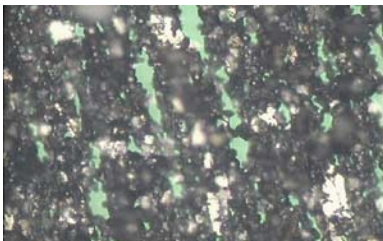
GEAR WEAR



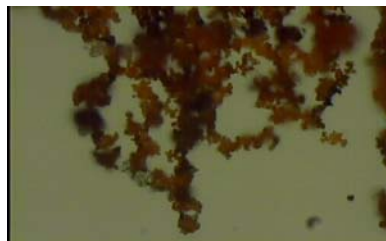
CORROSIVE WEAR



BLACK OXIDES



RED OXIDES



SPHERES



DATA ANALYSIS REPORTING PROCEDURES

Ashore Laboratory receives, tests and analyzes sample to produce raw data.

Data sent to MSC Internet FTP site.

Data imported into oil analysis software (OAS) at MSCHQ.

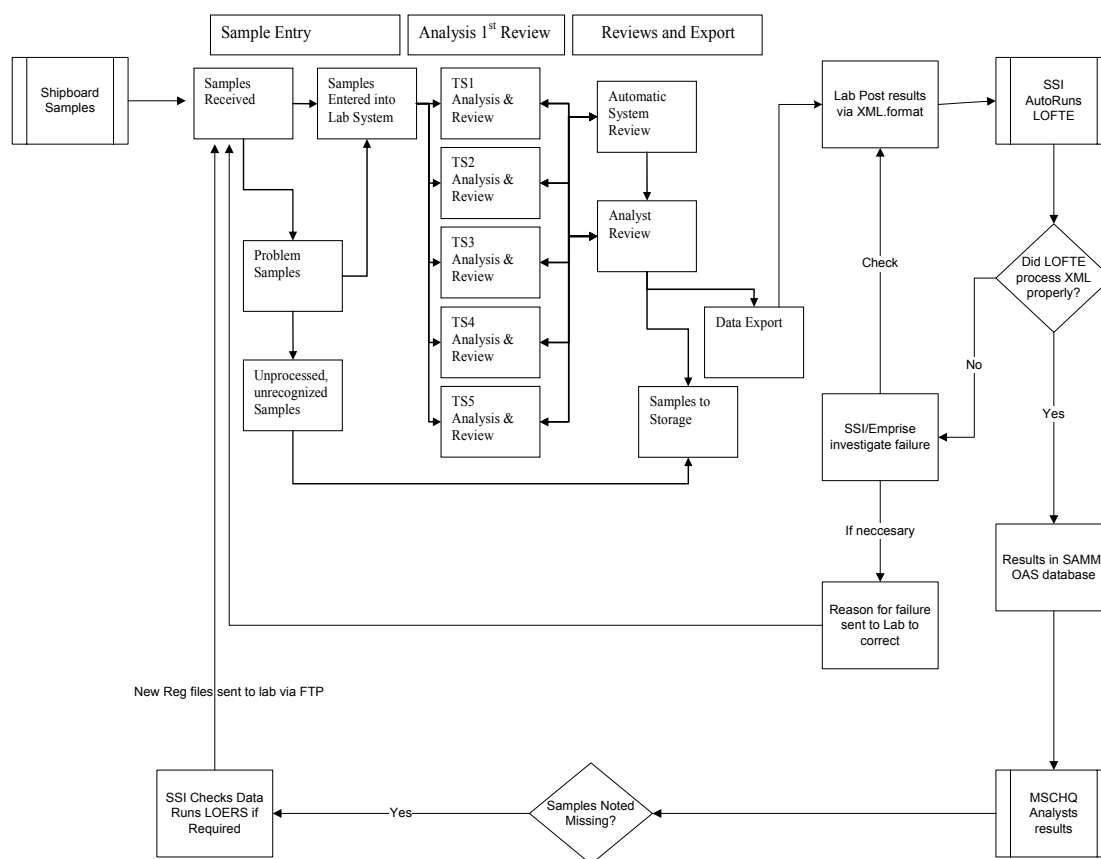
MSCHQ Data Analyst reviews data, provides analysis/interpretation and makes maintenance recommendations.

Data Analyst then prepares message (e-mail) report and sends to ship and PM personnel.

Abnormal samples are at the top and are sorted by priority.

Upon completion of analysis, data is archived in OAS database.

Data is replicated into SAMM 5.07 onboard ships.



SAMPLE OIL ANALYSIS MESSAGE REPORT

From: Ed Guevara

Sent: Thursday, August 28, 2003 11:45 AM

To: Bill Ingram (E-mail); Charles Larsen (E-mail); CHENG LENTHALL (E-mail); Larry Korn (E-mail); Michael Cipolla (E-mail); Michael Ragonese (E-mail)

Cc: 'paul.devoe@navy.mil'; 'edgardo.guevara@navy.mil'

Subject: USNS LENTHALL LUBE OIL SAMPLE TEST RESULTS//R 281651Z AUG 03

RAAUZYUW RULSMSC0001 0171022-UUUU--RHMCSUU RULSMSC ZNR UUUUU

R 281130Z AUG 03

FM COMSC WASHINGTON DC//N7//

TO USNS JOHN LENTHALL//

INFO MSC NFAF EAST NORFOLK VA//PM1E//

BT//

UNCLAS//N04700//

MSGID/GENADMIN/COMSC//

SUBJ/ USNS JOHN LENTHALL LUBE OIL SAMPLE TEST RESULTS//

RMKS/1. SAMPLES PROCESSED AT LAB 26AUG03. 19 SAMPLES IDENTIFIED WITH 3 ALERTS.

2. ALERTED SAMPLES:

A. NO.1 MOORING WINCH (PFA: 063): SAMPLE NUMBER: 030825011 DATE SAMPLED: 04AUG03

OBSERVATIONS: COPPER (26.00 PPM AND INCREASING), DISPERSED WATER (2074.00 PPM AND INCREASING), IRON (39.00 PPM AND INCREASING), SODIUM (69.00 PPM AND INCREASING).

MSCHQ ASSESSMENT AND RECOMMENDATIONS:

IMPORTANT: ANALYSIS INDICATES ABNORMAL CONDITIONS. INCREASE IN WATER CONTENT AND SODIUM LEVEL ARE NOTED. CORROSION OR WEAR OF SYSTEM COMPONENTS. RECOMMEND CHANGE OIL IF NOT ALREADY PERFORMED. CHECK SEALS, VENTS OR CASING FOR CONTAMINANT ENTRY. RESAMPLE AT THE NEXT SCHEDULED INTERVAL.

B. NO.8 FAS STATION SPANWIRE WINCH GEARBOX (PFA: 074): SAMPLE NUMBER: 030825010 DATE SAMPLED: 04AUG03

OBSERVATIONS: INSOLUBLES (0.23% AND INCREASING), HIGH VISCOSITY AT 40C (242.90 VS 150 CST AND INCREASING).

MSCHQ ASSESSMENT AND RECOMMENDATIONS:

DESIRABLE: ANALYSIS INDICATES ABNORMAL LUBRICANT CONDITIONS. VISCOSITY IS HIGH. INSOLUBLE CONTENT IS MODERATE. RECOMMEND CHANGE OIL IF NOT ALREADY PERFORMED. CHECK SUMP FOR DIRT IF APPLICABLE. RESAMPLE AT THE NEXT SCHEDULED INTERVAL.

C. NO.2 MOORING WINCH (PFA: 064): SAMPLE NUMBER: 030825014 DATE SAMPLED: 04AUG03
OBSERVATIONS: IRON (34.00 PPM AND INCREASING).

MSCHQ ASSESSMENT AND RECOMMENDATIONS:

NOTEWORTHY: ANALYSIS INDICATES COMPONENT CONDITION NEEDS MONITORING.
ELEVATED IRON LEVEL IS NOTED. RESAMPLE AT THE NEXT SCHEDULED INTERVAL.

3. NORMAL SAMPLES:

A. NO.2 FAS STATION GYPSY WINCH GEARBOX (PFA: 020): SAMPLE NUMBER: 030825001 DATE SAMPLED: 04AUG03

B. NO.4-1 ANTI-SLACK DEVICE GEARBOX (PFA: 485): SAMPLE NUMBER: 030825005 DATE SAMPLED: 04AUG03

C. NO.4 RAS STATION HIGHLINE WINCH GEARBOX (PFA: 059): SAMPLE NUMBER: 030825007 DATE SAMPLED: 04AUG03

D. NO.6 ANTI-SLACK DEVICE GEARBOX (PFA: 487): SAMPLE NUMBER: 030825009 DATE SAMPLED: 04AUG03

E. NO.3 RAS STATION HIGHLINE WINCH GEARBOX (PFA: 055): SAMPLE NUMBER: 030825013 DATE SAMPLED: 04AUG03

F. NO.7 FAS STATION GYPSY WINCH GEARBOX (PFA: 036): SAMPLE NUMBER: 030825015 DATE SAMPLED: 04AUG03

G. NO.6 FAS STAT SADDLE NO.3 WINCH GEARBOX (PFA: 029): SAMPLE NUMBER: 030825018 DATE SAMPLED: 04AUG03

H. NO.4 GENERATOR FWD BEARING (PFA: 111): SAMPLE NUMBER: 030825096 DATE SAMPLED: 14AUG03

I. STBD MAIN ENGINE A BANK TURBO COMPRESSOR (PFA: 506): SAMPLE NUMBER: 030825098 DATE SAMPLED: 14AUG03

J. NO.4 RAS STATION HAULING WINCH GEARBOX (PFA: 058): SAMPLE NUMBER: 030825002 DATE SAMPLED: 04AUG03

K. NO.1 ANTI-SLACK DEVICE GEARBOX (PFA: 481): SAMPLE NUMBER: 030825006 DATE SAMPLED: 04AUG03

L. NO.6 FAS STATION GYPSY WINCH GEARBOX (PFA: 025): SAMPLE NUMBER: 030825008 DATE SAMPLED: 04AUG03

M. NO.1 FAS STAT SADDLE NO.3 WINCH GEARBOX (PFA: 019): SAMPLE NUMBER: 030825012 DATE SAMPLED: 04AUG03

N. NO.5 MOORING WINCH (PFA: 067): SAMPLE NUMBER: 030825016 DATE SAMPLED: 04AUG03

O. STBD MAIN ENGINE B BANK TURBO COMPRESSOR (PFA: 507): SAMPLE NUMBER: 030825095 DATE SAMPLED: 14AUG03

P. PORT STERN TUBE LUBO COALESCER PUMP (PFA: 012): SAMPLE NUMBER: 030825097 DATE SAMPLED: 25AUG03

4. ALWAYS TAKE OIL SAMPLES FROM THE SAME LOCATION/POINT AND UNDER THE SAME OPERATING PARAMETERS AS THE PRIOR SAMPLE. USING THIS SAMPLING PROCEDURE WILL ENSURE MORE STABLE TREND ANALYSIS AND RESULT IN BETTER DATA BACK TO YOU.

5. RECORD COMPLETION OF DIAGNOSTICS AND/OR CORRECTIVE ACTIONS ON LUBE OIL ALERTS IN SAMM'S MACHINERY HISTORY.
 6. FIREFIGHTING FOAM IS AVAILABLE ON THE WORLDWIDE CHEMICAL CONTRACT. PLACE YOUR ORDERS FOR FIREFIGHTING FOAM IN THE SAME WAY YOU WOULD FOR BOILER OR OTHER TREATMENT CHEMICALS. SEE DAMAGE CONTROL INFORMATION NEWSLETTER DCIN 072 FIREFIGHTING FOAM CONCENTRATE CONTRACT INFORMATION [HTTP://WWW.MSC.NAVY.MIL/N7/DC_INFO/DCIN072.HTM](http://www.msc.navy.mil/n7/dc_info/dcinfo72.htm) . IF YOU ARE STILL UNSURE WHICH FOAM YOU SHOULD ORDER, CONTACT BRADDOCK.PARKS@NAVY.MIL BY E-MAIL FOR PRODUCT INFORMATION.
 7. DATA ANALYSIS PERFORMED BY EDGARDO GUEVARA N712E 202-685-5730.
- BT//

OIL ANALYSIS DATA IN SAMM CMS MODULE

Oil Analysis Software
File Edit View Tools Actions Window Configure Help

Auto Status: MANUAL <...

USNS Lenthall -> DECK_SHIP HANDLING -> NO.1 MOORING WINCH

Selection List: **New Samples** Equipment

- DAMAGE CONTROL & LIFESAVING
- DECK & SHIP HANDLING
 - ANCHOR WINDLASS HPU
 - NO.1 ANCHOR WINDLASS
 - NO.1 MOORING WINCH**
 - NO.2 ANCHOR WINDLASS
 - NO.2 MOORING WINCH
 - NO.3 MOORING WINCH
 - NO.4 MOORING WINCH
 - NO.5 MOORING WINCH
 - NO.6 MOORING WINCH
 - PORT STEERING GEAR UNIT
 - STBD STEERING GEAR UNIT
- ELECTRICAL GENERATION & DIST
- FUEL OIL
- HVAC SYSTEM
- LUBE OIL
- MISSION/UNREP/VERTREP/CARGO
- PROPULSION
 - PORT CRP PROPELLER SYSTEM
 - PORT LINE SHAFT BEARING
 - PORT MAIN ENGINE
 - PORT MAIN ENGINE A BANK TUF
 - PORT MAIN ENGINE B BANK TUF
 - PORT MAIN ENGINE B BANK TUF
 - PORT MAIN ENGINE B BANK TUF
 - PORT MAIN PROPULSION REDU
 - PORT ROCKER ARM LUBE OIL S
 - PORT STERN TUBE LUBE COALE
 - STBD CRP PROPELLER SYSTEM
 - STBD LINE SHAFT BEARING
 - STBD MAIN ENGINE
 - STBD MAIN ENGINE A BANK TUF

Oil Sample Point

Vessel: USNS Lenthall LSD Equipment: NO.1 MOORING WINCH
 PFA No: 2034063 Sample Point: NO.1 MOORING WINCH
 Lubricant: MOBILGEAR 629 Std. Meas Pt: Unknown
 META: NO DEF Std. Slate: Unknown

	02/09/04	08/04/03	02/03/03
FLASH POINT	---	---	---
FUEL DIL	---	---	---
PERCENT WATER	---	---	---
WATER VISUAL	---	---	---
WATER DISP	500	2074	500
NAT WATER	---	---	---
GLYCOL	---	---	---
INSOL Sol %WT	0.03	0.06	0.01
SOOT INDEX	---	---	---
PQ INDEX	13	37	7
IRON	12	39	17
CHROMIUM	0	0	0
TITANIUM	0	0	0
NICKEL	0	0	0
LEAD	0	1	0
COPPER	6	26	19
TIN	1	1	0
ALUMINUM	0	0	0
SILVER	---	---	---
SILICON	4	12	8
SODIUM	10	69	37

ANALYSIS INDICATES ABNORMAL CONDITIONS. INCREASE IN WATER CONTENT AND SODIUM LEVEL ARE NOTED. CORROSION OR WEAR OF SYSTEM COMPONENTS. RECOMMEND CHANGE OIL IF NOT ALREADY PERFORMED. CHECK SEALS, VENTS OR CASING FOR CONTAMINANT ENTRY. RESAMPLE AT THE NEXT SCHEDULED INTERVAL.

User: Guevara, Edgardo CAPS NUM SCR 11:47:44

WARNING LIMITS

PROPERTY	ASTM METHOD	TURBINE	HYDRAULIC	CIRCULATING OIL	GEAR	COMPRESSOR	HVAC COMPRESOR	ENGINES
VISC % CHANGE	D 445	10	10	10	25	25		15
TAN* (MG/G)	D 974/D 664	1.0	2.0	2.0	2.0	2.0	0.1**/1.0	
TBN DEPLETION %	D 2896							>50
WATER % MAX	D1744	0.1	0.1	0.2	0.2	0.2	0.015**/0.15	0.2
INSOLUBLES % MAX	FTIR	1.0	1.0	2.0	2.5	2.0		2.0

* Above New Oil Baseline

** Wax free oils

Note: These are guidelines only and may vary depending on oil/application.